IN THE SPECIFICATION

Please amend the title to read "PROXIMITY DETECTION CIRCUIT AND METHOD OF DETECTING CAPACITANCE CHANGES".

Please replace paragraphs [0001] through [0003] with the following:

[0001] ~~This file is a Continuation-in-Part of Ser. No. 09/780,733, filed Feb. 9, 2001.~~ The present application is a continuation of U.S. Patent Application No. 09/966,275, filed September 27, 2001, now U.S. Patent No. ________, which is a continuation-in-part of U.S. Patent No. 6,592,067, filed February 9, 2001, the disclosures of which are incorporated herein by reference.

[0002] ~~This invention relates to the field of paper roll dispensers. In particular it relates to a carousel dispensing system for paper towels adapted to dispense paper from a plurality of rolls.~~ This invention relates to the field of proximity sensors. In particular it relates to the field of phase-balance proximity sensors. It relates to spurious noise-immune proximity sensors.

[0003] As is readily apparent, a long-standing problem is to keep paper ~~towel~~ towels available in a dispenser and at the same time use up each roll as completely as possible to avoid paper waste. As part of this system, one ought to keep in mind the person who refills the towel dispenser. An optimal solution would make it as easy as possible and as "fool-proof" as possible to operate the towel refill system and have it operate in such a manner as the least amount of waste of paper towel occurs. This waste may take the form of "stub" rolls of paper towel not being used up.

Please replace paragraphs [0015] through [0017] with the following:

[0015] ~~The invention comprises to a carousel-based dispensing system for paper towels, in particular, which acts to minimize actual wastage of paper towels. The~~

~~invention comprises means for holding and positioning at least first and second rolls of paper with respect to each other, means for dispensing paper from the first roll, means for dispensing paper from the first and second rolls simultaneously when the first roll reduces to a predetermined diameter of paper, means for positioning the depleted first roll for replacement without the necessity of removing the second roll and means for dispensing from the second and replacement rolls simultaneously when the second roll reduces to a predetermined diameter of paper.~~ The present invention is directed towards a proximity detection circuit and a method of detecting capacitance changes. The proximity detector circuit comprises an antenna, an oscillator circuit adapted to provide charge to the antenna, a detector circuit adapted to receive an antenna signal and generate a detection signal in response thereto, the antenna signal being representative of an external capacitive load on the antenna, and a comparator which is adapted to receive the detection signal and generate an output signal in response thereto. The oscillator circuit may generate either a symmetric or asymmetric signal. The method of detecting capacitance changes comprises charging an antenna with an oscillating signal, either symmetric or asymmetric, detecting changes in the antenna signal with a detector circuit, generating a detection signal from the detector circuit in response to changes in the antenna signal, and generating an output signal in response to the detection signal.

[0016] ~~A proximity sensor embodiment comprises a circuit according to a balanced bridge principle where detection is based on detecting a phase difference, which depends upon the amount of detected capacitance difference or change of capacitance in a region of detection.~~ In a first separate aspect of the present invention, the impedance mismatch between the antenna and the detector circuit is buffered. An operational amplifier, operated as a unity gain follower and disposed between the antenna and the detector circuit, is a suitable component for buffering the impedance

mismatch. With such a configuration, the antenna signal passes through the operational amplifier before being received by the detector circuit.

[0017] ~~A second embodiment of this invention comprises a second electronic proximity sensor. The second detector circuit is a miniaturized, micro-powered, capacitance-based proximity sensor designed to detect the approach of a hand to a towel dispenser. It features stable operation and a three-position sensitivity selector.~~ In a second separate aspect of the present invention, the various electronic components are protected from static that may otherwise have a negative effect on the detection circuit. The static protection circuit includes at least one first diode conducting away from ground and at least one second diode conducting toward a supply voltage.

Please add the following paragraphs after paragraph [0017]:

[0017.1] In a third separate aspect of the present invention, any of the foregoing aspects may be employed in combination.

[0017.2] Accordingly, it is an object of the present invention to provide an improved proximity detection circuit and a method of detecting capacitance changes. Other objects and advantages will appear hereinafter.

Please replace paragraph [0033] with the following:

[0033] FIG. 4A shows the dispenser case 48 with the carousel assembly 30 and transfer bar 44. The carousel assembly 30 is fully loaded with a main roll 66 in the secondary position and a stub roll 68 in the primary position, both mounted on the carousel arms 32 ~~and~~ to rotate on the rotating reduced friction paper towel roll hubs 34 (only shown from the back of the carousel arms 32). In the carousel assembly 30, the two carousel arms 32, joined by corresponding bars 40 and cross members 42, rotate in carousel fashion about a horizontal axis defined by the carousel assembly rotation hubs 38. The locking bar 36 is supported, or carried, by a corresponding bar 40. The

corresponding bar 40 provides structural rigidity and support. The locking bar 36 principally serves as a locking mechanism. Each paper towel roll 66, 68 has an inner cardboard tube which acts as a central winding core element, and which provides in a hole in paper towel roll 66, 68 at each end for engaging the hubs 34.

Please replace paragraph [0050] with the following:

[0050] An embodiment of the invention comprises a balanced bridge circuit. See FIG. 8A. The component U1A 90, which forms part of the oscillator sub-circuit, is a comparator (TLC3702 158) configured as an oscillator. The frequency of oscillation of this component, U1A 90, of the circuit may be considered arbitrary and non-critical, as far as the operation of the circuit is concerned. The period of the oscillator is set by the elements C_{ref} 92, R_{hys} 94, the trim resistance, R_{trim} 96, where the trim resistance may be varied and the range resistors R_{range} 152 are fixed. The resistors R_{range} 152 allow limits to be placed on the range of adjustment, resulting in an easier adjustment. The adjustment band is narrowed, since only part of the total resistance there can be varied. Consequently a single potentiometer may be used, simplifying the adjustment of R_{trim} 96. A value for R_{range} 152 for the schematic shown in FIG. 8A might be 100 kΩ. R_{trim} 96 might have an adjustment range of 10 kΩ to 50 kΩ. The output signal at pin 1 98 of component U1A 90 is a square wave, as shown in FIG. 9A. C_{ref} 92 is charged by the output along with ANT 100, both sustaining the oscillation and measuring the capacitance of the adjacent free space. The signals resulting from the charging action, referred to herein as the antenna signal, are applied to a second comparator, U1B 102, at pin 5 104 and pin 6 106 (FIG. 8A). This second comparator forms part of the detector sub-circuit. These signals appear as exponential waveforms, as shown in FIG. 9B and FIG. 9C.

Please replace paragraph [0052] with the following:

[0052] The output signal at pin 1 98 of component U1A 90, e.g., a TL3702 158, is a square wave, as shown in FIG. [[2A]] 8A. Two waveforms are generated at the inputs of the second comparator, U2B 102. The first comparator 90 is running as an oscillator producing a square-wave clocking signal, which is input, to the clock input of the flip-flop U2A 108, which may be, for example, a Motorola D flip-flop, No. 14013.

Please replace paragraph [0054] with the following:

[0054] An external pull-up resistor, $R_{pullup1}$ 116, which may have a value, for example, of 470 Ω, is only necessary if an open collector, comparator such as an LM393 154 is used. That comparator 154 acts as an open-collector output with a ground-coupled emitter. For low power consumption, better performance is achieved with a CMOS comparator, e.g., TLC3702, which utilizes a CMOS push-pull output 156. The signal at terminal 3 110 of U1A charges a capacitor C_{ref} 92 and also charges an ANT sensor 100 with a capacitance which C_{ref} 92 is designed to approximate. A value for C_{ref} for the schematic of FIG. 8A, for the most current board design, upon which it depends, is about 10 pF. As the clocking square wave is effectively integrated by C_{ref} 92 and the capacitance of ANT 100, two exponential signals appear at terminals 5 104 and 6 106 of the second comparator U1B, through the $R_{protect}$ 160 static protection resistors. $R_{protect}$ 160 resistors provide limiting resistance which enhances the inherent static protection of a comparator input lines, particularly for the case of pin 5 104 of U1B 102. In the schematic shown in FIG. 8A, a typical value for $R_{protect}$ 160 might be 2 kΩ. One of the two exponential waveforms will be greater, depending upon the settings of the adjustable resistance R_{trim} 96, C_{ref} 92, and ANT 100. The comparator U1B 102 resolves small differences, reporting logic levels at its output, pin 7 118. The logic levels at the output of U1B 102 represent the detection signal. As the waveforms may initially be set up, based on a capacitance at ANT 100 of a given amount. However, upon the intrusion of a hand, for example, into the detection field of the antenna ANT 100, the capacitance

of ANT 100 is increased significantly and the prior relationship of the waveforms, which were set with ANT 100 with a lower capacitance, are switched over. Therefore, the logic level output at pin 7 118 is changed and the d flip-flop 108 state is changed via the input on pin 5 of the D flip-flop 108. The detection signal is thus responsive to changes in the antenna signal.

Please replace paragraph [0068] with the following:

[0068] ~~At the heart of the~~ The proximity detector of FIG. 10A is an oscillator circuit in the form of an adjustable asymmetric rectangular wave oscillator running in a range of 24 kHz to 40 kHz~~, as shown in FIG. 10A~~. Once an initial adjustment has been set it is not readjusted during operation, normally. The asymmetrical feature of having a longer on-time and shorter off-time allows for more useable signal, i.e., on-time. This 24 kHz to 40 kHz oscillation range provides a basis for a high rate of sampling of the environment to detect capacitance changes, as detailed below. As shown, a fast comparator, XU2A 200, has positive feedback through XR1 8 202 from the output terminal 1 204 (XU2A) to the positive input terminal 3 206 (XU2A). The comparator operates as a Schmitt trigger oscillator with positive feedback to the non-inverting input, terminal. The positive feedback insures a rapid output transition, regardless of the speed of the input waveform. As the capacitor XC6 208 is charged up, the terminal 3 206 of the XU2A 200 comparator reaches 2/3 XV_{DD}. This voltage 2/3 XV_{DD} is maintained on terminal 3 206 by the voltage dividing network XR17 212 and XR20 214, and the positive feedback resistor XR18 202 that is in parallel with XR17 212, where XR17 212 and XR20 214 and XR18 202 are all equal resistances. The simplest form of a comparator is a high-gain differential amplifier, made either with transistors or with an op-amp. The op-amp goes into positive or negative saturation according to the difference of the input voltages because the voltage gain is typically larger than 100,000, the inputs will have to be equal to within a fraction of a millivolt in order for the

output not to be completely saturated. Although an ordinary op-amp can be used as comparator, there are special integrated circuits intended for this use. For low power consumption, better performance is achieved with a CMOS comparator, such as a TEXAS INSTRUMENT® TLC3702CD 158 (FIG. 8B). The TLC 3702 158 is a micropower dual comparator with CMOS push-pull 156 (FIG. 8B) outputs. These dedicated comparators are much faster than the ordinary op-amps.

Please replace paragraphs [0074] and [0075] with the following:

[0074] If a hand of a person is placed in proximity to the antenna of the circuit, the capacitance of the antenna to free space may double to about 15 pF with a resultant longer time constant and lower amplitude exponential waveform. The time constant τ is increased to about 26 μs. While it is possible to directly compare the antenna signals, it is also desirable to have as stable an operating circuit as possible while retaining a high sensitivity and minimizing false positives and false negatives with respect to detection. To aid in achieving these goals, the antenna signal is conditioned or processed first.

[0075] Looking at the operational amplifier XU1A 242, the (antenna signal) waveform sees very high impedance, since operational amplifiers have high input impedance. The impedance on the antenna 236 side of the operational amplifier 242, in the form of resistance, is about 1.9 MΩ. The impedance on the other side of the operational amplifier is of the order of 5 kΩ. In order to provide an impedance buffer ~~the signal~~ to the antenna signal, the operational amplifier UX1A 242 is set up as a unity follower with a voltage gain of 1.0, that is, the gain given by V_{out}/V_{in} equals one. The unity follower has an input-side (of the operational amplifier) resistance of about 1.0 TΩ (10^{13} Ω). The (operational amplifier's) output impedance is in a range about 40 to 600 to several thousand ohms. Consequently, this unity follower configuration serves to isolate or buffer the upstream high-impedance circuit from the downstream low impedance circuit.

Please replace paragraph [0078] with the following:

[0078] The diode XD1 258 allows positive forward conduction but cuts off the negative backward conduction of a varying signal pulse. The forward current, or positive peak of the current, tends to charge the capacitor XC5 260. The diode XD1 258, the resistor XR8 262, the capacitor XC5 260 and the bleed resistor XR10 264 comprise <u>a detection sub-circuit, which in FIG. 10B is</u> a peak detector network. XD1 258 and XC5 260 capture the positive peak of the exponential waveform. XR8 262 prevents oscillation of XU1A 242. XR8 262 limits the charging time constant to 5 ms, where XR8 262 is 4.99 kΩ and XC5 260 is 0.1 μF. This has an averaging effect on the peak detection and prevents noise spikes from pumping up the detector. The resistor XR10 264 discharges the detector at a half-second time constant<u>, the discharge being a detection signal</u>.

Please replace paragraph [0081] with the following:

[0081] The <u>detection</u> signal is next amplified by an operational amplifier XU1B 268, which has a gain of 22. The resistor XR5 277 serves as a feedback resistor to the negative (inverting) input terminal 279 of the operational amplifier 268. There is a 1/2 XV_{DD} offset provided by the voltage divider network of XR3 274 and XR11 276. The output rests against the negative rail until a peak exceeds 1/2 XV_{DD}. The charge time adjustment XVR1 becomes a very simple and sensitive way to adjust to this threshold. A setting of 3 V between test points XTP1 278 and XTP2 280 is recommended. This adjustment is made with all external capacitive loads (i.e., plastic and metal components) in place.

Please replace paragraph [0084] with the following:

[0084] The output stage of the proximity detector is implemented as a variable threshold comparator, XU2B 282. The detection signal is set up with an offset voltage, where the resistors XR7 292 and XR12 294 are equal and divide the VDD voltage into two 1/2 VDD segments. Three sensitivity settings are provided by SW1 296, high, medium, and low. These settings include where the reference voltage is the voltage drop across XR6 298 (499 kΩ) with the remainder of the voltage divider equal to XR19 300 (453 kΩ) plus XR16 302 (20 kΩ) plus XR14 304 (10 kΩ). This is the high setting, since the base reference voltage (V_{DD}•499/[499+483]} is greater than, but almost equal to the base detection signal value (V_{DD}•499/[499+499]}. The detection signal must overcome, i. e., become smaller than the reference voltage (since the input is an inverting input), in order to swing the output 306 of the comparator XU2B 282 high and activate, say, a motor-control latch (not shown in FIG. 10D). The medium sensitivity setting, in FIG. 10E, of switch XSW1 296 (bypassing XR14, 304 10 kΩ, by way of switch XSW1 296) widens the difference between the detection signal and reference levels. The low sensitivity setting (bypassing XR14 304, 10 kΩ, and XR16 302, 20 kΩ, by way of switch XSW1 296), widens that difference between the detection signal and reference levels even more. Consequently, a larger difference between the detection signal and the reference voltage must be overcome to activate the motor by way of the comparator XU2B 282 and the motor-control latch (not shown in FIG. 10D).

Please replace the abstract of the specification with the following:

A proximity detection circuit. An oscillator circuit is adapted to provide charge to an antenna. An operational amplifier, operated as a unity gain follower, receives an antenna signal which is representative of an external capacitive load on the antenna. A detector circuit receives the antenna signal via the operational amplifier and outputs a detection signal in response to changes in the antenna signal. A comparator receives the detection signal and is adapted to generate an output signal in response thereto.